

**Amber Helm Development L.C.**

92723 Michigan Hwy-152

Sister Lakes, Michigan 49047 USA

Tel: 888-847-8027

# EMC Test Report

**TAP3-1702200**

Issued: November 9, 2017

regarding

**USA: CFR Title 47, Part 15.209** (Emissions)  
**Canada: ISSED RSS-GEN** (Emissions)

for



## SX8TAP3

**Category: LF Transceiver**

Judgements:

**FCC 15.209 / ISSED RSS-GEN Compliant**

Tested: November 9, 2017



NVLAP LAB CODE 200129-0

Prepared for:

## Bartec USA, LLC

44231 Phoenix Drive, Sterling Heights Michigan 48314 USA


Phone: 586-803-7005

Fax:

Contact: Michael Rose

mrose@bartecusa.com

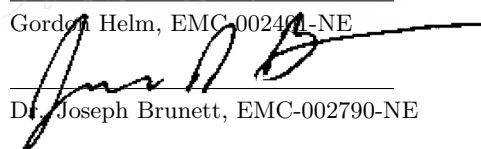
Data Recorded by:

  
Gordon Helm, EMC-002474-NE

Reviewed by:

  
Dave Miller, EMC-003027-NE

Prepared by:

  
Dr. Joseph Brunett, EMC-002790-NE

Date of Issue: November 9, 2017

## Revision History

| Rev. No. | Date              | Details                 | Revised By |
|----------|-------------------|-------------------------|------------|
| 0        | November 9, 2017  | Initial Release.        | J. Brunett |
| 1        | November 12, 2017 | AC Mains clarification. | J. Brunett |

## Contents

|   |           |
|---|-----------|
| <b>Revision History</b>   | <b>2</b>  |
| <b>Table of Contents</b>  | <b>2</b>  |
| <b>1 Test Report Scope and Limitations</b>                            | <b>4</b>  |
| 1.1 Laboratory Authorization . . . . .                                | 4         |
| 1.2 Report Retention . . . . .  | 4         |
| 1.3 Subcontracted Testing . . . . .                                   | 4         |
| 1.4 Test Data . . . . .   | 4         |
| 1.5 Limitation of Results . . . . .                                   | 4         |
| 1.6 Copyright . . . . .   | 4         |
| 1.7 Endorsements . . . . .  | 4         |
| 1.8 Test Location . . . . .   | 5         |
| 1.9 Traceability and Equipment Used . . . . .                         | 5         |
| <b>2 Test Specifications and Procedures</b>                           | <b>6</b>  |
| 2.1 Test Specification and General Procedures . . . . .               | 6         |
| <b>3 Configuration and Identification of the Equipment Under Test</b> | <b>7</b>  |
| 3.1 Description and Declarations . . . . .                            | 7         |
| 3.1.1 EUT Configuration . . . . .                                     | 7         |
| 3.1.2 Modes of Operation . . . . .                                    | 7         |
| 3.1.3 Variants . . . . .  | 8         |
| 3.1.4 Test Samples . . . . .  | 8         |
| 3.1.5 Functional Exerciser . . . . .                                  | 8         |
| 3.1.6 Modifications Made . . . . .                                    | 8         |
| 3.1.7 Production Intent . . . . .                                     | 8         |
| 3.1.8 Declared Exemptions and Additional Product Notes . . . . .      | 8         |
| <b>4 Emissions</b>  | <b>9</b>  |
| 4.1 General Test Procedures . . . . .                                 | 9         |
| 4.1.1 Radiated Test Setup and Procedures . . . . .                    | 9         |
| 4.1.2 Conducted Emissions Test Setup and Procedures . . . . .         | 11        |
| 4.1.3 Power Supply Variation . . . . .                                | 11        |
| 4.2 Intentional Emissions . . . . .                                   | 13        |
| 4.2.1 Fundamental Emission Pulsed Operation . . . . .                 | 13        |
| 4.2.2 Fundamental Emission Bandwidth . . . . .                        | 14        |
| 4.2.3 Fundamental Emission . . . . .                                  | 16        |
| 4.3 Unintentional Emissions . . . . .                                 | 17        |
| 4.3.1 Transmit Chain Spurious Emissions . . . . .                     | 17        |
| 4.3.2 General Radiated Spurious . . . . .                             | 18        |
| 4.3.3 Conducted Emissions Test Results - AC Power Port(s) . . . . .   | 20        |
| <b>5 Measurement Uncertainty and Accreditation Documents</b>          | <b>21</b> |

## List of Tables

|    |   |    |
|----|---|----|
| 1  | Test Site List. . . . .                               | 5  |
| 2  | Equipment List. . . . .                               | 5  |
| 3  | EUT Declarations. . . . .                             | 7  |
| 4  | Pulsed Emission Characteristics (Duty Cycle). . . . . | 13 |
| 5  | Intentional Emission Bandwidth. . . . .               | 14 |
| 6  | Fundamental Radiated Emissions. . . . .               | 16 |
| 7  | Transmit Chain Spurious Emissions. . . . .            | 17 |
| 8  | Radiated Digital Spurious Emissions. . . . .          | 18 |
| 8  | Radiated Digital Spurious Emissions. . . . .          | 19 |
| 9  | AC Mains Power Conducted Emissions Results. . . . .   | 20 |
| 9  | AC Mains Power Conducted Emissions Results. . . . .   | 20 |
| 10 | Measurement Uncertainty. . . . .                      | 21 |

## List of Figures

|   |   |    |
|---|---|----|
| 1 | Photos of EUT. . . . .                                | 7  |
| 2 | EUT Test Configuration Diagram. . . . .               | 8  |
| 3 | Radiated Emissions Diagram of the EUT. . . . .        | 9  |
| 4 | Radiated Emissions Test Setup Photograph(s). . . . .  | 10 |
| 5 | Conducted Emissions Setup Diagram of the EUT. . . . . | 11 |
| 6 | Conducted Emissions Test Setup Photograph(s). . . . . | 12 |
| 7 | Intentional Emission Bandwidth. . . . .               | 15 |
| 8 | Accreditation Documents . . . . .                     | 21 |

## **1 Test Report Scope and Limitations**

### **1.1 Laboratory Authorization**

Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: 90413) and with ISED Canada, Ottawa, ON (File Ref. No: IC3161). Amber Helm Development L.C. holds accreditation under NVLAP Lab Code 200129-0 and includes within its scope CFR Title 47 Part 15 Subparts B and C.

### **1.2 Report Retention**

For equipment verified to comply with the regulations herein, the manufacturer is obliged to retain this report with the product records for the life of the product, and no less than ten years. A copy of this Report will remain on file with this laboratory until November 2027.

### **1.3 Subcontracted Testing**

This report does not contain data produced under subcontract.

### **1.4 Test Data**

This test report contains data included within the laboratories scope of accreditation.

### **1.5 Limitation of Results**

The test results contained in this report relate only to the item(s) tested. Any electrical or mechanical modification made to the test item subsequent to the test date shall invalidate the data presented in this report. Any electrical or mechanical modification made to the test item subsequent to this test date shall require reevaluation.

### **1.6 Copyright**

This report shall not be reproduced, except in full, without the written approval of Amber Helm Development L.C..

### **1.7 Endorsements**

This report shall not be used to claim product endorsement by any accrediting, regulatory, or governmental agency.

## 1.8 Test Location

The EUT was fully tested by **Amber Helm Development L.C.**, 92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA. Table 1 lists all sites employed herein. Specific test sites utilized are also listed in the test results sections of this report.

Table 1: Test Site List.

| Description     | Location   | Quality Num. |
|-----------------|--|--------------|
| OATS (3m & 10m) | 92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA | OATSA        |

## 1.9 Traceability and Equipment Used

Pertinent test equipment used for measurements at this facility is listed in Table 2. The quality system employed at Amber Helm Development L.C. has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to the SI through NIST, other recognized national laboratories, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards.

Table 2: Equipment List.

| Description           | Manufacturer/Model      | SN                        | Quality Num. | Last Cal By / Date Due |
|-----------------------|-------------------------|---------------------------|--------------|------------------------|
| Spectrum Analyzer     | Rohde & Schwarz / FSV30 | 101660                    | RSFSV30001   | RS / May-2018          |
| EMI Receiver          | HP / 85460A/85462A      | 3704A00422,<br>3807A00465 | HP8546A      | Techmaster / Apr-2018  |
| (3m) RG8 Coax         | CS-3227 / CS-3227       | C060914                   | CS3227       | AHD / Mar-2018         |
| (3m) LMR-400 Coax     | AHD / LMR400            | C090804                   | LMR400       | AHD / Mar-2018         |
| (LCI) DS Coax         | AHD / RG58/U            | 920809                    | RG58U        | AHD / Jan-2018         |
| Shielded Loop Antenna | EMCO / 6502             | 9502-2926                 | EMCOLOOP1    | Lib. Labs. / Aug-2018  |
| BiconiLog Antenna     | EMCO / 3142             | 1169                      | BILO3142     | Lib.Labs / May-2018    |
| Double Ridged Horn    | EMCO / 3115             | 2788                      | RH3115       | Lib.Labs. / July-2018  |

## 2 Test Specifications and Procedures

### 2.1 Test Specification and General Procedures

The ultimate goal of Bartec USA, LLC is to demonstrate that the Equipment Under Test (EUT) complies with the Rules and/or Directives below. Detailed in this report are the results of testing the Bartec USA, LLC SX8TAP3 for compliance to:

| Country/Region | Rules or Directive          | Referenced Section(s)     |
|----------------|-----------------------------|---------------------------|
| United States  | Code of Federal Regulations | CFR Title 47, Part 15.209 |
| Canada         | ISED Canada                 | ISED RSS-GEN              |

It has been determined that the equipment under test is subject to the rules and directives above at the date of this testing. In conjunction with these rules and directives, the following specifications and procedures are followed herein to demonstrate compliance (in whole or in part) with these regulations.

|   |  |
|---|--|
| ANSI C63.4:2014                             | "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" |
| ANSI C63.10:2013 (USA)                      | "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"                                       |
| IEEE Trans. EMC, Vol. 47, No. 3 August 2005 | "Extrapolating Near-Field Emissions of Low-Frequency Loop Transmitters," J.D.Brunett, V.V.Liepa, D.L.Sengupta                          |
| TP0102RA                                    | "AHD Internal Document TP0102 - Radiated Emissions Test Procedure"   |
| ISED Canada                                 | "The Measurement of Occupied Bandwidth"  |
| ICES-003; Issue 6 (2016)                    | "Information Technology Equipment (ITE) Limits and methods of measurement"   |

### 3 Configuration and Identification of the Equipment Under Test

#### 3.1 Description and Declarations

The equipment under test is a transceiver designed for LF activation (125 kHz) and RF reception (315 MHz and 433 MHz) from Tire Pressure Monitor (TPM) Sensors. The EUT is approximately 20 x 6 x 8 cm in dimension, and is depicted in Figure 1. It is powered by 4.2 VDC lithium polymer battery. In use, this device is used by tire shops and dealers who install TPM sensors into vehicle rims. Table 3 outlines provider declared EUT specifications.



Figure 1: Photos of EUT.

Table 3: EUT Declarations.

|                             |                |                            |                       |
|-----------------------------|----------------|----------------------------|-----------------------|
| <b>General Declarations</b> |                |                            |                       |
| <b>Equipment Type:</b>      | LF Transceiver | <b>Country of Origin:</b>  | Not Declared          |
| <b>Nominal Supply:</b>      | 4.2 VDC        | <b>Oper. Temp Range:</b>   | Not Declared          |
| <b>Frequency Range:</b>     | 125 kHz        | <b>Antenna Dimension:</b>  | 4 cm                  |
| <b>Antenna Type:</b>        | coil           | <b>Antenna Gain:</b>       | Integral              |
| <b>Number of Channels:</b>  | 1              | <b>Channel Spacing:</b>    | None                  |
| <b>Alignment Range:</b>     | Not Declared   | <b>Type of Modulation:</b> | AM+CW                 |
| <b>United States</b>        |                |                            |                       |
| <b>FCC ID Number:</b>       | SX8TAP3        | <b>Classification:</b>     | DCD                   |
| <b>Canada</b>               |                |                            |                       |
| <b>IC Number:</b>           | 5736A-TAP3     | <b>Classification:</b>     | Remote Control Device |

##### 3.1.1 EUT Configuration

The EUT is configured for testing as depicted in Figure 2.

##### 3.1.2 Modes of Operation

When the EUT is in charging mode, no LF or RF radios are in operation and the display only shows battery state. In normal use (once charged) a large number of LF transmit protocols can be selected by the user on this device based

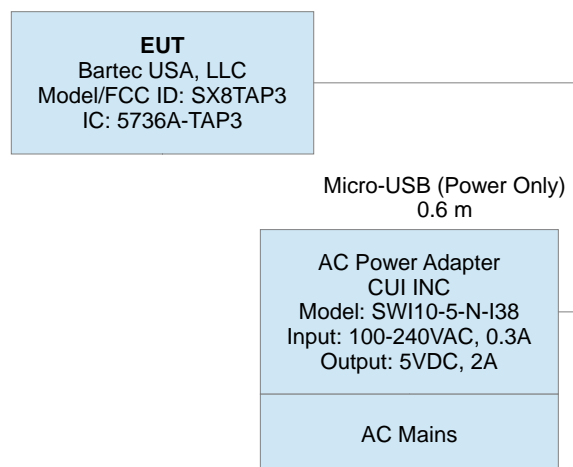


Figure 2: EUT Test Configuration Diagram.

on vehicle make and model. The range of LF protocols are provided in an associated exhibit, and the worst case emissions are reported herein. The CW test mode was determined to have the highest fundamental and harmonic emissions and is fully reported. Worst case EBW was measured for the maximum and minimum AM modulated protocols. Spurious emissions were measured with the EUT LF transmitter, both UHF receivers, and integral BLE module all in active states, as well as when the EUT is in charging mode.

### 3.1.3 Variants

There is only a single variant of the EUT, as tested.

### 3.1.4 Test Samples

Two samples were provided for testing; one sample for photographs and one normal operating sample with additional custom test software that produced the worst-case modes of operation. The custom test software allowed for modulated 125 kHz transmission at the highest possible data rate, 125 kHz CW transmission, a 315 MHz / 433 MHz receiver active mode, and continuous transmission by the integral (pre-approved) Bluetooth module.

### 3.1.5 Functional Exerciser

EUT functionality was verified by observation of transmitted signal.

### 3.1.6 Modifications Made

There were no modifications made to the EUT by this laboratory.

### 3.1.7 Production Intent

The EUT appears to be a production ready sample.

### 3.1.8 Declared Exemptions and Additional Product Notes

This EUT also employs a pre-certified fully modular Bluetooth radio, FCC ID: QOQWT12, IC: 5123A-BGTWT12A with integral antenna. The LF transmitter, active UHF receiver, and digital spurious emissions from this fully assembled EUT are detailed in this report.



## 4 Emissions

### 4.1 General Test Procedures

#### 4.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first pre-scanned in our screen room. Spectrum and modulation characteristics of all emissions are recorded. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.8 are employed. After pre-scan, emission measurements are made on the test site of record. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in relevant test standards are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 3. All intentionally radiating elements that are not fixed-mounted in use are placed on the test table lying flat, on their side, and on their end (3-axes) and the resulting worst case emissions are recorded. If the EUT is fixed-mounted in use, measurements are made with the device oriented in the manner consistent with installation and then emissions are recorded. If the EUT exhibits spurious emissions due to internal receiver circuitry, such emissions are measured with an appropriate carrier signal applied.

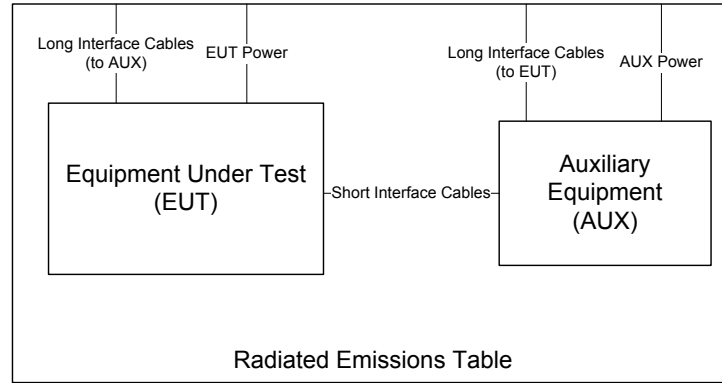


Figure 3: Radiated Emissions Diagram of the EUT.

For devices with intentional emissions below 30 MHz, a shielded loop antenna and/or E-field and H-Field broadband probes are used depending on the regulations. Shielded loops are placed at a 1 meter receive height at the desired measurement distance. For exposure in this band, the broadband probes employed are 10cm diameter single-axis shielded transducers and measurements are repeated and summed over three axes.

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. For both horizontal and vertical polarizations, the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected. The EUT is then rotated through  $360^\circ$  in azimuth until the highest emission is detected. The test antenna is then raised and lowered one last time from 1 to 4 m and the worst case value is recorded. Emissions above 1 GHz are characterized using standard gain or broadband ridge-horn antennas on our OATS with a  $4 \times 5$  m rectangle of ECCOSORB absorber covering the OATS ground screen. Care is taken to ensure that test receiver resolution and video bandwidths meet the regulatory requirements, and that the emission bandwidth of the EUT is not reduced. Photographs of the test setup employed are depicted in Figure 4.

Where regulations allow for direct measurement of field strength, power values (dBm) measured on the test receiver / analyzer are converted to  $\text{dB}\mu\text{V}/\text{m}$  at the regulatory distance, using

$$E_{dist} = 107 + P_R + K_A - K_G + K_E - C_F$$

where  $P_R$  is the power recorded on spectrum analyzer, in dBm,  $K_A$  is the test antenna factor in dB/m,  $K_G$  is the combined pre-amplifier gain and cable loss in dB,  $K_E$  is duty correction factor (when applicable) in dB, and  $C_F$  is a distance conversion (employed only if limits are specified at alternate distance) in dB. This field strength value is then compared with the regulatory limit. If effective isotropic radiated power (EIRP) is computed, it is computed as

$$\text{EIRP}(\text{dBm}) = E_{3m}(\text{dB}\mu\text{V}/\text{m}) - 95.2.$$

When presenting data at each frequency, the highest measured emission under all possible EUT orientations (3-axes) is reported.



Figure 4: Radiated Emissions Test Setup Photograph(s).

#### 4.1.2 Conducted Emissions Test Setup and Procedures

**AC Port Conducted Spurious** For this device, AC power line conducted emissions are measured in our screen room. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR 22 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 5.

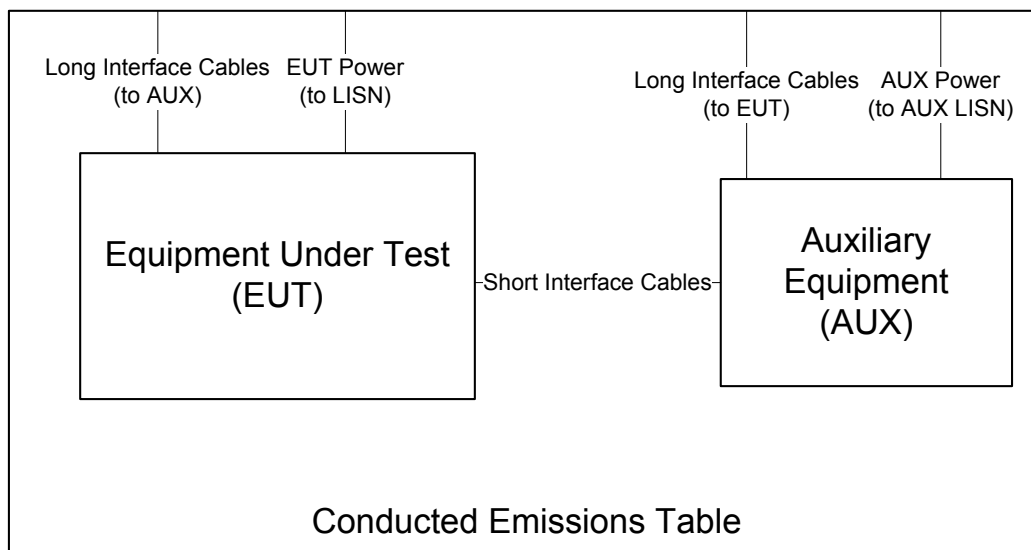


Figure 5: Conducted Emissions Setup Diagram of the EUT.

Conducted emissions are measured and recorded for each AC mains power source over the spectrum 0.15 MHz to 30 MHz for both the ungrounded (HI/PHASE) and grounded (LO/GND) conductors with the EUT placed in its highest current draw operating mode(s). The test receiver is set to peak-hold mode in order to record the peak emissions throughout the course of functional operation. Only if an emission exceeds or is near the limit are quasi-peak and average detection applied. Photographs of the test setup employed are depicted in Figure 6.

#### 4.1.3 Power Supply Variation

Tests at extreme supply voltages are made if required by the the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case of this EUT, measurements of the worst-case radiated emissions are performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value for devices connecting to AC power mains.



Figure 6: Conducted Emissions Test Setup Photograph(s).

## 4.2 Intentional Emissions

### 4.2.1 Fundamental Emission Pulsed Operation

The details and results of testing the EUT for pulsed operation are summarized in Table 4.

Table 4: Pulsed Emission Characteristics (Duty Cycle).

|                        |            |                     |                        |                        |                  |
|------------------------|------------|---------------------|------------------------|------------------------|------------------|
| <b>Frequency Range</b> | <b>Det</b> | <b>IF Bandwidth</b> | <b>Video Bandwidth</b> | <b>Test Date:</b>      | 3-Nov-17         |
| 9 kHz f 150 kHz        | Pk/QPk     | 200 Hz              | 300 Hz                 | <b>Test Engineer:</b>  | Gordon Helm      |
| 150 kHz f 30 MHz       | Pk/QPk     | 9 kHz/10 kHz        | 30 kHz                 | <b>EUT Mode:</b>       | Normal Operating |
| 25 MHz f 1 000 MHz     | Pk/QPk     | 120 kHz             | 300 kHz                | <b>Meas. Distance:</b> | 60 cm            |
| f > 1 000 MHz          | Pk         | 3 MHz               | 3MHz                   | <b>EUT Tested:</b>     | Bartec SX8TAP3   |
| f > 1 000 MHz          | Avg        | 3 MHz               | 10kHz                  |                        |                  |

| # | EUT Mode         | Overall Transmission       |                    |                                 | Internal Frame Characteristics |                       |   | Computed Duty Cycle* |           |
|---|------------------|----------------------------|--------------------|---------------------------------|--------------------------------|-----------------------|---|----------------------|-----------|
|   |                  | Min. Repetition Rate (sec) | Max. No. of Frames | Total Transmission Length (sec) | Max. Frame Length (ms)         | Min. Frame Period (s) | Frame Encoding  | (%)                  | Duty (dB) |
|   |                  |                            |                    |                                 |                                |                       |   |                      |           |
| 1 | Normal (125 kHz) | CW                         | N/A                | >100ms                          | N/A                            | N/A                   | The EUT employs a CW signal > 100ms, so duty cycle is not applied for this product. | 100.000              | 0.0       |

\* No Duty Cycle is employed when demonstrating compliance.

#### 4.2.2 Fundamental Emission Bandwidth

Emission bandwidth (EBW) of the EUT is measured with the device placed in the test mode(s) with the shortest available frame length and minimum frame spacing. Radiated emissions are recorded following the test procedures listed in Section 2.1. The 20 dB EBW is measured as the max-held peak-detected signal when the IF bandwidth is greater than or equal to 1% of the receiver span. For complex modulations other than ASK and FSK, the 99% emission bandwidth per IC test procedures has a different result, and is also separately reported. The results of EBW testing are summarized in Table 5. Plots showing measurements employed to obtain the emission bandwidth reported are provided in Figure 7.

Table 5: Intentional Emission Bandwidth.

|                        |            |                     |                        |                        |                  |
|------------------------|------------|---------------------|------------------------|------------------------|------------------|
| <b>Frequency Range</b> | <b>Det</b> | <b>IF Bandwidth</b> | <b>Video Bandwidth</b> | <b>Test Date:</b>      | 6-Nov-17         |
| 9 kHz f 150 kHz        | Pk         | > 1% Span           | >= 3 * IFBW            | <b>Test Engineer:</b>  | Joseph Brunett   |
| 150 kHz f 30 MHz       | Pk         | > 1% Span           | >= 3 * IFBW            | <b>EUT Mode:</b>       | Normal Operating |
|                        |            |                     |                        | <b>Meas. Distance:</b> | 0.6 m            |
|                        |            |                     |                        | <b>EUT Tested:</b>     | Bartec SX8TAP3   |

| # | Mode          | Freq.<br>(kHz) | Supply<br>(VDC) | 20 dB EBW<br>(kHz) | 99% PWR BW<br>(kHz) | 110 kHz Restricted Band<br>dBc |  |  |  |  |
|---|---------------|----------------|-----------------|--------------------|---------------------|--------------------------------|--|--|--|--|
| 1 | CW            | 125            | 4.7             | 2.6                | 2.0                 | > 50                           |  |  |  |  |
| 2 | Max Data Rate | 125            | 4.7             | 32.5               | 48.6                | 24.9                           |  |  |  |  |
| 3 | Min Data Rate | 125            | 4.7             | 4.5                | 11.7                | >35                            |  |  |  |  |

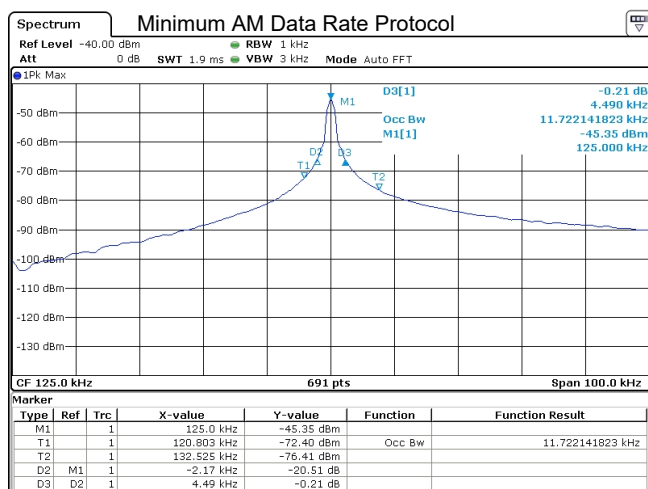
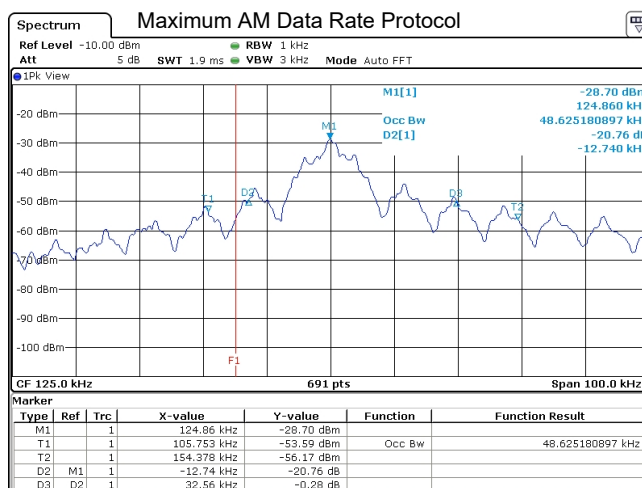
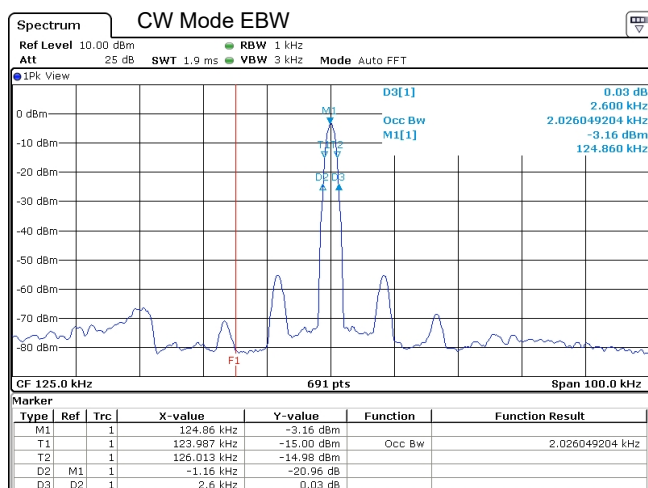


Figure 7: Intentional Emission Bandwidth.

### 4.2.3 Fundamental Emission

Following the test procedures listed in Section 2.1, field emissions measurements are made on the EUT for both Horizontal and Vertically polarized coupling fields. The EUT's loop antenna(s) are measured when the EUT loop axes are (1) aligned along the same axis as the test loop antenna and horizontal with respect to the test site ground plane, (2) aligned coplanar (in the same plane) with the test antenna and aligned horizontal with respect to the test site ground plane, and (3) aligned coplanar (in the same plane) with the test antenna and vertical with respect to the test site ground plane. Table 6 details the results of these measurements.

Table 6: Fundamental Radiated Emissions.

| Frequency Range    | Det    | IF Bandwidth | Video Bandwidth | Test Date:      | 3-Nov-17          |
|--------------------|--------|--------------|-----------------|-----------------|-------------------|
| 9 kHz f 150 kHz    | Pk/QPk | 200 Hz       | 300 Hz          | Test Engineer:  | Gordon Helm       |
| 150 kHz f 30 MHz   | Pk/QPk | 9 kHz        | 30 kHz          | EUT Mode:       | CW +Max Modulated |
| 25 MHz f 1 000 MHz | Pk/QPk | 120 kHz      | 300 kHz         | Meas. Distance: | 3 meters          |
| f > 1 000 MHz      | Pk     | 1 MHz        | 3MHz            | EUT Tested:     | Bartec SX8TAP3    |
| f > 1 000 MHz      | Avg    | 1 MHz        | 3MHz            |                 |                   |

| Fundamental Emissions Measurements |                |                 |           |              |                 |                |         |       |                   |                                   |  |  |  |            |      |
|------------------------------------|----------------|-----------------|-----------|--------------|-----------------|----------------|---------|-------|-------------------|-----------------------------------|--|--|--|------------|------|
| #                                  | Mode           | EUT Orientation | Freq. MHz | Ant. Used QN | Ant.** Height m | Table Azim deg | Ka dB/m | Kg dB | CF** 3m / 300m dB | E-field @ 3m Pk dBuV/m Avg dBuV/m |  | E-field @ 300m Avg dBuV/m Limit Avg dBuV/m |  | Pass By*** |      |
| 1                                  | CW + Modulated | Flat            | 0.125     | EMCOLOOP1    | 1.0             | 90             | 10.1    | 0.0   | 80.0              | 76.0                              |  | -4.0                                       |  | 25.7       | 29.7 |
| 2                                  |                | Side            | 0.125     | EMCOLOOP1    | 1.0             | 90             | 10.1    | 0.0   | 80.0              | 76.6                              |  | -3.4                                       |  | 25.7       | 29.1 |
| 3                                  |                | End             | 0.125     | EMCOLOOP1    | 1.0             | 90             | 10.1    | 0.0   | 80.0              | 66.0                              |  | -14.0                                      |  | 25.7       | 39.7 |

\* EUT was tested in CW mode. No averaging applies and Quasi-Peak data was not needed to demonstrate compliance.

\*\* Emissions were evaluated at 1m test antenna height. Cf computed as 40 dB/dec per FCC / ISED guidelines (Near Field < 30 MHz)



## 4.3 Unintentional Emissions

### 4.3.1 Transmit Chain Spurious Emissions

The results for the measurement of transmit chain spurious emissions at the nominal voltage and temperature are provided in Table 7. Following the test procedures listed in Section 2.1, field emissions measurements are made on the EUT for both Horizontal and Vertically polarized coupling fields. The EUT's loop antenna(s) are measured when the EUT loop axes are (1) aligned along the same axis as the test loop antenna and horizontal with respect to the test site ground plane, (2) aligned coplanar (in the same plane) with the test antenna and aligned horizontal with respect to the test site ground plane, and (3) aligned coplanar (in the same plane) with the test antenna and vertical with respect to the test site ground plane. The results for the measurement of transmit chain spurious emissions at the nominal voltage and temperature are provided in Table 7. Measurements are performed to 10 times the highest fundamental operating frequency.

Table 7: Transmit Chain Spurious Emissions.

|                        |            |                     |                        |                        |               |
|------------------------|------------|---------------------|------------------------|------------------------|---------------|
| <b>Frequency Range</b> | <b>Det</b> | <b>IF Bandwidth</b> | <b>Video Bandwidth</b> | <b>Test Date:</b>      | 3-Nov-17      |
| 9 kHz f 150 kHz        | Pk/QPk     | 200 Hz              | 300 Hz                 | <b>Test Engineer:</b>  | Gordon Helm   |
| 150 kHz f 30 MHz       | Pk/QPk     | 9 kHz               | 30 kHz                 | <b>EUT Mode:</b>       | Normal + Load |
| 25 MHz f 1 000 MHz     | Pk/QPk     | 120 kHz             | 300 kHz                | <b>Meas. Distance:</b> | 3 m           |
| f > 1 000 MHz          | Pk         | 3 MHz               | 3MHz                   | <b>EUT Tested:</b>     | Bartec TAP3   |
| f > 1 000 MHz          | Avg        | 3 MHz               | 10kHz                  |                        |               |

| Transmit Chain Spurious Emissions |                         |                 |           |           |                 |                |         |       |                     |               |                |                    |            |                      |             |          |
|-----------------------------------|-------------------------|-----------------|-----------|-----------|-----------------|----------------|---------|-------|---------------------|---------------|----------------|--------------------|------------|----------------------|-------------|----------|
| #                                 | Mode                    | EUT Orientation | Freq. kHz | Ant. Used | Ant ** Height m | Table Azim deg | Ka dB/m | Kg dB | Cf** (3 to 300m) dB | E-field @ 3m* |                | E-field @ 300m/30m |            |                      | Pass By     | Comments |
|                                   |                         |                 |           |           |                 |                |         |       |                     | Pk dBuV/m     | Avg/Qpk dBuV/m | Pk dBuV/m          | Qpk dBuV/m | Limit Avg/Qpk dBuV/m |             |          |
| 1                                 | CW + Max Rate Modulated | Max All, Worst  | 375.0     | EMCOLOOP1 | 1.0             | 90.0           | 10.0    | 0.0   | 80.0                | 61.0          |                | -19.0              |            | 16.1                 | 35.1        |          |
| 2                                 |                         | Max All, Worst  | 625.0     | EMCOLOOP1 | 1.0             | 90.0           | 10.0    | 0.0   | 40.0                | 59.0          |                | 19.0               |            | 31.7                 | 12.7        |          |
| 3                                 |                         | Max All, Worst  | 875.0     | EMCOLOOP1 | 1.0             | 80.0           | 10.2    | 0.0   | 40.0                | 51.0          |                | 11.0               |            | 28.8                 | 17.8        |          |
| 4                                 |                         | Max All, Worst  | 1362.0    | EMCOLOOP1 | 1.0             | 100.0          | 10.2    | 0.0   | 40.0                | 54.0          |                | 14.0               |            | 24.9                 | <b>10.9</b> |          |
| 5                                 |                         | Max All, Worst  | 5375.0    | EMCOLOOP1 | 1.0             | 80.0           | 10.1    | 0.0   | 40.0                | 46.0          |                | 6.0                |            | 29.5                 | 23.5        |          |
| 6                                 |                         |                 |           |           |                 |                |         |       |                     |               |                |                    |            |                      |             |          |

\* EUT was tested for CW and max-rate modulated modes. No averaging is applied below 490 kHz and Quasi-Peak data was not needed to demonstrate compliance.

\*\* Emissions were evaluated at 1m test antenna height. Test antenna was rotated 360 degrees.

### 4.3.2 General Radiated Spurious

The results for the measurement of general spurious emissions (emissions arising from digital circuitry) at the nominal voltage and temperature are provided in Table 8. Radiation from digital components are measured up to 1000 MHz or to the highest frequency required by the applied standards, whichever is greater.

Table 8(a): Radiated Digital Spurious Emissions.

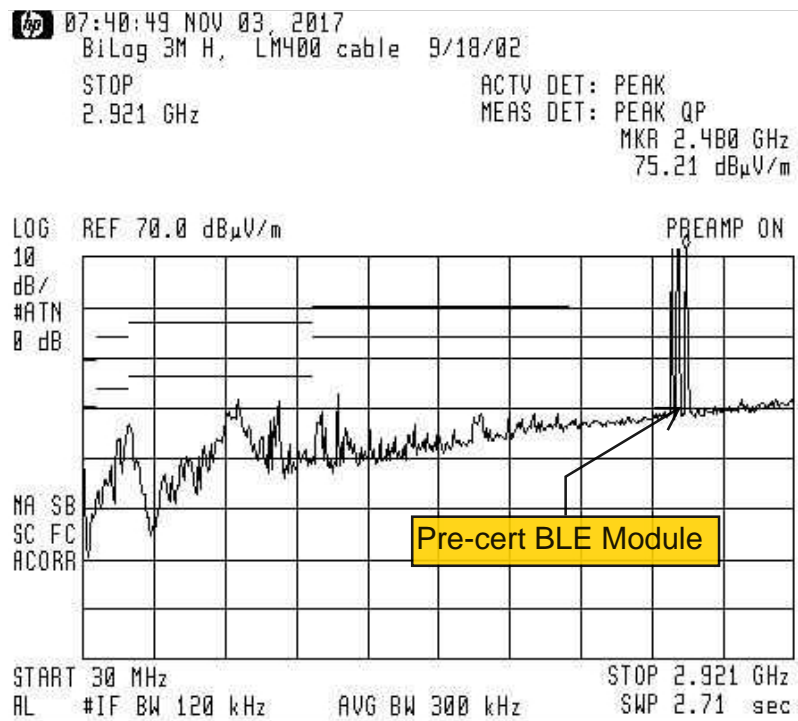
| Frequency Range |               | Det    | IF Bandwidth | Video Bandwidth | Test Date:      |                |
|-----------------|---------------|--------|--------------|-----------------|-----------------|----------------|
| 25 MHz          | f < 1 000 MHz | Pk/QPk | 120 kHz      | 300 kHz         | Test Engineer:  | 3-Nov-17       |
| f > 1 000 MHz   |               | Pk     | 1 MHz        | 3 MHz           | EUT:            | Gordon Helm    |
| f > 1 000 MHz   |               | Avg    | 1 MHz        | 10kHz           | EUT Mode:       | Bartec SX8TAP3 |
|                 |               |        |              |                 | Meas. Distance: | CW + Max Mod   |
|                 |               |        |              |                 |                 | 3 meters       |

| Digital Spurious Emissions |           |           |           |                 |              |         |       |               |                    |                          |                               | FCC/IC  |          |
|----------------------------|-----------|-----------|-----------|-----------------|--------------|---------|-------|---------------|--------------------|--------------------------|-------------------------------|---------|----------|
| #                          | Freq. MHz | Ant. Used | Ant. Pol. | Table Azim. deg | Ant Height m | Ka dB/m | Kg dB | E3(Pk) dBμV/m | E3(QPk/Avg) dBμV/m | FCC/IC E3lim (Pk) dBμV/m | FCC/IC E3lim (Qpk/Avg) dBμV/m | Pass dB | Comments |
| 1                          | 64.0      | BILO3142  | H         | 90.0            | 1.4          | 9.6     | -4    | 24.9          | 18.9               | 60.0                     | 40.0                          | 21.1    |          |
| 2                          | 72.0      | BILO3142  | V         | 140.0           | 1.0          | 8.7     | -5    | 36.5          | 31.9               | 60.0                     | 40.0                          | 8.1     |          |
| 3                          | 72.6      | BILO3142  | V         | 150.0           | 1.0          | 8.6     | -5    | 25.7          | 18.0               | 60.0                     | 40.0                          | 22.0    |          |
| 4                          | 74.6      | BILO3142  | H         | 180.0           | 1.0          | 8.4     | -5    | 23.2          | 17.8               | 60.0                     | 40.0                          | 22.2    |          |
| 5                          | 105.0     | BILO3142  | H         | 180.0           | 1.0          | 7.2     | -6    | 24.3          | 19.0               | 63.5                     | 43.5                          | 24.5    |          |
| 6                          | 105.1     | BILO3142  | V         | 230.0           | 1.0          | 7.2     | -6    | 32.4          | 28.3               | 63.5                     | 43.5                          | 15.2    |          |
| 7                          | 194.0     | BILO3142  | H         | 180.0           | 1.6          | 12.0    | -8    | 33.0          | 29.0               | 63.5                     | 43.5                          | 14.5    |          |
| 8                          | 199.8     | BILO3142  | V         | 140.0           | 1.0          | 12.4    | -8    | 27.5          | 23.1               | 63.5                     | 43.5                          | 20.4    |          |
| 9                          | 200.0     | BILO3142  | V         | 230.0           | 1.0          | 12.4    | -8    | 30.7          | 25.1               | 63.5                     | 43.5                          | 18.4    |          |
| 10                         | 202.5     | BILO3142  | H         | 170.0           | 1.6          | 12.6    | -8    | 32.5          | 28.6               | 63.5                     | 43.5                          | 14.9    |          |
| 11                         | 204.8     | BILO3142  | H         | 230.0           | 1.0          | 12.7    | -9    | 26.9          | 21.3               | 63.5                     | 43.5                          | 22.2    |          |
| 12                         | 206.4     | BILO3142  | V         | 100.0           | 1.0          | 12.8    | -9    | 29.4          | 24.3               | 63.5                     | 43.5                          | 19.2    |          |
| 13                         | 216.0     | BILO3142  | H         | 180.0           | 1.0          | 13.4    | -9    | 20.0          | 17.0               | 63.5                     | 43.5                          | 26.5    |          |
| 14                         | 463.0     | BILO3142  | V         | 130.0           | 1.0          | 17.5    | -1.6  | 31.7          | 26.7               | 66.0                     | 46.0                          | 19.3    |          |
| 15                         | 539.0     | BILO3142  | V         | 0.0             | 1.0          | 18.0    | -1.8  | 34.7          | 30.7               | 66.0                     | 46.0                          | 15.3    |          |
| 16                         | 540.0     | BILO3142  | H         | 340.0           | 1.7          | 18.0    | -1.8  | 34.9          | 26.0               | 66.0                     | 46.0                          | 20.0    |          |
| 17                         | 648.0     | BILO3142  | V         | 270.0           | 1.0          | 20.6    | -2.1  | 33.0          | 32.5               | 66.0                     | 46.0                          | 13.5    |          |
| 18                         | 824.0     | BILO3142  | V         | 150.0           | 1.0          | 24.9    | -2.6  | 35.5          | 33.5               | 66.0                     | 46.0                          | 12.5    |          |
| 19                         | 824.0     | BILO3142  | H         | 20.0            | 1.5          | 24.9    | -2.6  | 35.4          | 33.4               | 66.0                     | 46.0                          | 12.6    |          |
| 20                         | 840.0     | BILO3142  | V         | 150.0           | 1.0          | 25.1    | -2.7  | 39.3          | 37.3               | 66.0                     | 46.0                          | 8.7     |          |
| 21                         | 840.0     | BILO3142  | H         | 20.0            | 1.5          | 25.1    | -2.7  | 36.7          | 34.4               | 66.0                     | 46.0                          | 11.6    |          |
| 22                         |           |           |           |                 |              |         |       |               |                    |                          |                               |         |          |
| 23                         |           |           |           |                 |              |         |       |               |                    |                          |                               |         |          |

Table 8(b): Radiated Digital Spurious Emissions.

## PRESCAN PLOT



### 4.3.3 Conducted Emissions Test Results - AC Power Port(s)

The results of emissions from the EUT's AC mains power port(s) are reported in Table 9.

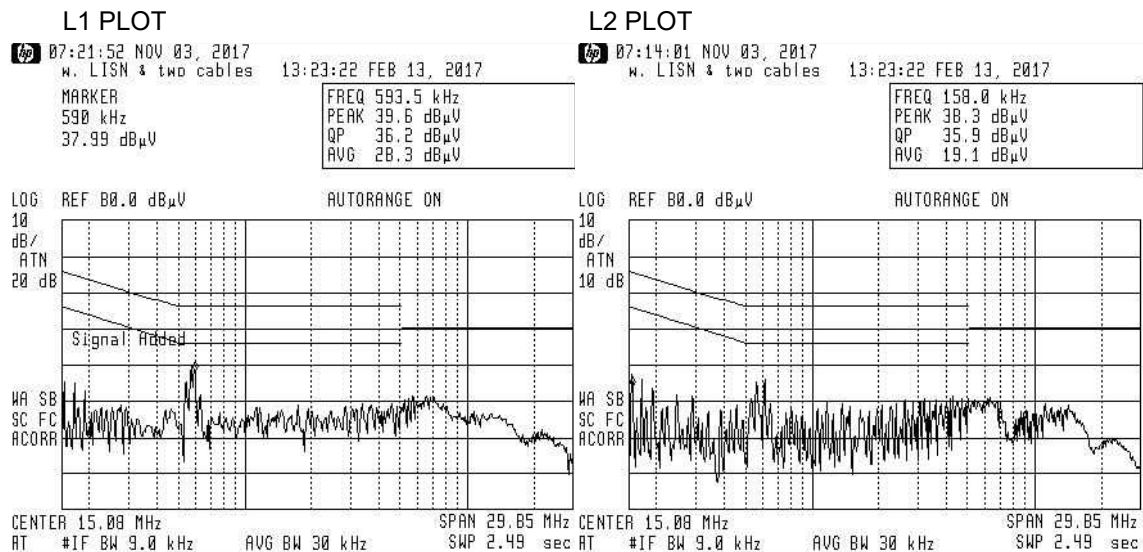
Table 9(a): AC Mains Power Conducted Emissions Results.

|                        |                 |                     |                        |                        |                    |
|------------------------|-----------------|---------------------|------------------------|------------------------|--------------------|
| <b>Frequency Range</b> | <b>Det</b>      | <b>IF Bandwidth</b> | <b>Video Bandwidth</b> | <b>Test Date:</b>      | 3-Nov-17           |
| 150kHz f 30 MHz        | Pk/QPk/Avg      | 9 kHz               | 30 kHz                 | <b>Test Engineer:</b>  | Gordon Helm        |
|                        |                 |                     |                        | <b>EUT Mode:</b>       | CW + Modulating    |
|                        |                 |                     |                        | <b>EUT:</b>            | Bartec TAP3        |
| <b>AC Mains:</b>       | 115 VAC, 60 Hz. |                     |                        | <b>Meas. Distance:</b> | AC Mains Conducted |

| AC Mains Power Conducted Emissions |           |           |         |                |          |                        |           |                        |           |                        |           |                        |           |          |
|------------------------------------|-----------|-----------|---------|----------------|----------|------------------------|-----------|------------------------|-----------|------------------------|-----------|------------------------|-----------|----------|
| #                                  | Freq. MHz | Line Side | Pk dBuV | Vmeas Qpk dBuV | Avg dBuV | Class A Qpk Vlim* dBuV | Margin dB | Class A Avg Vlim* dBuV | Margin dB | Class B Qpk Vlim* dBuV | Margin dB | Class B Avg Vlim* dBuV | Margin dB | Comments |
| 1                                  | 0.158     | L1        |         | 35.9           | 19.1     | 79.0                   | 43.1      | 66.0                   | 46.9      | 65.6                   | 29.7      | 55.5                   | 36.4      |          |
| 2                                  | 0.300     | L1        |         | 26.0           | 12.0     | 79.0                   | 53.0      | 66.0                   | 54.0      | 60.3                   | 34.3      | 50.2                   | 38.2      |          |
| 3                                  | 0.581     | L1        |         | 35.0           | 24.0     | 73.0                   | 38.0      | 60.0                   | 36.0      | 54.8                   | 19.8      | 46.0                   | 22.0      |          |
| 4                                  | 4.900     | L1        |         | 27.0           | 14.0     | 73.0                   | 46.0      | 60.0                   | 46.0      | 56.0                   | 29.0      | 46.0                   | 32.0      |          |
| 5                                  | 5.900     | L1        |         | 27.0           | 14.0     | 73.0                   | 46.0      | 60.0                   | 46.0      | 60.0                   | 33.0      | 50.0                   | 36.0      |          |
| 6                                  | 11.800    | L1        |         | 24.0           | 9.0      | 73.0                   | 49.0      | 60.0                   | 51.0      | 60.0                   | 36.0      | 50.0                   | 41.0      |          |
| 7                                  |           |           |         |                |          |                        |           |                        |           |                        |           |                        |           |          |
| 8                                  | 0.162     | L2        |         | 29.0           | 15.0     | 79.0                   | 50.0      | 66.0                   | 51.0      | 65.4                   | 36.4      | 55.3                   | 40.3      |          |
| 9                                  | 0.176     | L2        |         | 32.0           | 21.0     | 79.0                   | 47.0      | 66.0                   | 45.0      | 64.7                   | 32.7      | 54.6                   | 33.6      |          |
| 10                                 | 0.217     | L2        |         | 29.0           | 20.0     | 79.0                   | 50.0      | 66.0                   | 46.0      | 62.9                   | 33.9      | 52.9                   | 32.9      |          |
| 11                                 | 0.593     | L2        |         | 36.2           | 28.3     | 73.0                   | 36.8      | 60.0                   | 31.7      | 56.0                   | 19.8      | 46.0                   | 17.7      |          |
| 12                                 | 1.100     | L2        |         | 28.0           | 17.0     | 73.0                   | 45.0      | 60.0                   | 43.0      | 56.0                   | 28.0      | 46.0                   | 29.0      |          |
| 13                                 | 6.600     | L2        |         | 29.0           | 21.0     | 73.0                   | 44.0      | 60.0                   | 39.0      | 60.0                   | 31.0      | 50.0                   | 29.0      |          |
| 14                                 |           |           |         |                |          |                        |           |                        |           |                        |           |                        |           |          |
| 15                                 |           |           |         |                |          |                        |           |                        |           |                        |           |                        |           |          |

\*In all cases, VPk VQpk VAve. If VPk < Vavg limit, then VQPk limit and Vavg limit are met.

Table 9(b): AC Mains Power Conducted Emissions Results.



## 5 Measurement Uncertainty and Accreditation Documents

The maximum values of measurement uncertainty for the laboratory test equipment and facilities associated with each test are given in the table below. This uncertainty is computed for a 95.45% confidence level based on a coverage factor of  $k = 2$ .

Table 10: Measurement Uncertainty.

| Measured Parameter                                 | Measurement Uncertainty <sup>†</sup>                            |
|--|---|
| Radio Frequency                                    | $\pm(f_{Mkr}/10^7 + RBW/10 + (SPN/(PTS - 1))/2 + 1 \text{ Hz})$ |
| Conducted Emm. Amplitude                           | $\pm 1.9 \text{ dB}$  |
| Radiated Emm. Amplitude (30 – 200 MHz)             | $\pm 4.0 \text{ dB}$  |
| Radiated Emm. Amplitude (200 – 1000 MHz)           | $\pm 5.2 \text{ dB}$  |
| Radiated Emm. Amplitude ( $f > 1000 \text{ MHz}$ ) | $\pm 3.7 \text{ dB}$  |

<sup>†</sup>Ref: CISPR 16-4-2:2011+A1:2014

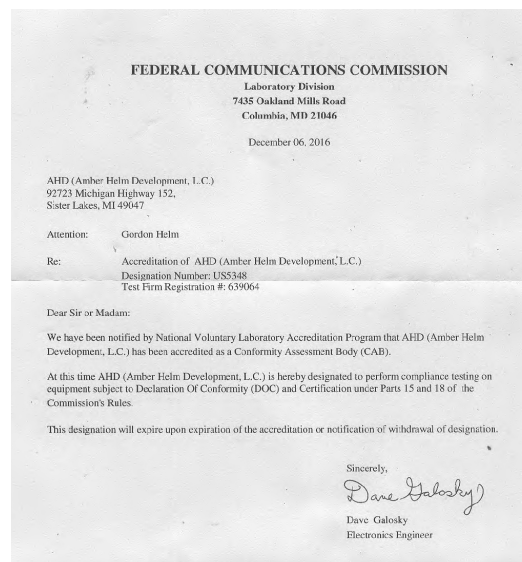


Figure 8: Accreditation Documents